

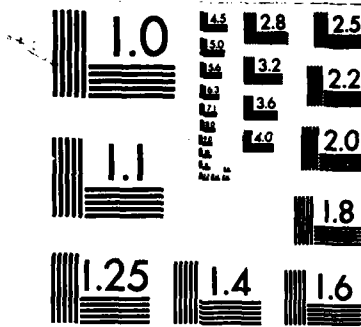
NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS  
WILLIAMS LAKE DAM (MA.) (U) CORPS OF ENGINEERS WALTHAM  
MA NEW ENGLAND DIV DEC 80

UNCLASSIFIED

F/G 13/13

NL

[illegible]



MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A

AD-A155 011

**FINAL** GEOTECHNICAL ENGINEERING  
BRANCH

MERRIMACK RIVER BASIN  
MARLBOROUGH, MASSACHUSETTS

**WILLIAMS LAKE DAM**

MA. 00451

**PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM**

DTIC FILE COPY



**DTIC**  
ELECTRONIC  
JUN 11 1985

DEPARTMENT OF THE ARMY  
NEW ENGLAND DIVISION, CORPS OF ENGINEERS  
WALTHAM, MASS. 02154

**RECEIVED**

MAR 10 1981

**DISTRIBUTION STATEMENT A**

Approved for public release  
Distribution Unlimited

Geotech. Engrg. Br.

DECEMBER 1980

85 5 22 041

NATIONAL PROGRAM OF INSPECTION OF NON-FEDERAL DAMS  
DRAFT REPORT REVIEW COMMENTS

WILLIAMS LAKE DAM, IDENTITY NO. MA 00451

GEOTECHNICAL ENGINEERING BRANCH

Page No.

Comments

8	Par. 3.1 c : Discuss clarity of seepage.
Section 3	General : Photos may be referenced incorrectly. Have no photo 4 or photo 5. Ref. to 5 sounds like 3.
15	7.2 (3) : Reword statement as follows " Design and construct a means to safely drain the lake." or something similar to this. The need for this is already evident.
	7.2 (5) : Include trees <del>on the crest and</del> within so many feet of the toe. Eliminate brush.
16	7.3 : Include a recommendation to remove all brush and debris from the dam and spillway, and within so many feet of the toe.
General	Is the dam presently used for water supply or is it just one of the city's options for emergency water supply if needed?

**UNCLASSIFIED**

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER MA 00451	2. GOVT ACCESSION NO. <b>AD-4155 611</b>	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle)  Williams Lake Dam  NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		5. TYPE OF REPORT & PERIOD COVERED  INSPECTION REPORT
7. AUTHOR(s)  U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS		8. CONTRACT OR GRANT NUMBER(s)
11. CONTROLLING OFFICE NAME AND ADDRESS DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE December 1980
		13. NUMBER OF PAGES 42
		15. SECURITY CLASS. (of this report)  UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report)  APPROVAL FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)  DAMS, INSPECTION, DAM SAFETY,  Merrimack River Basin Marlborough, Massachusetts Millham Brook		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)  Williams Lake Dam is an earth embankment dam with a downstream rubble masonry wall. The dam is about 183 ft. long and 6 ft. high. The dam is small in size and has a hazard potential of high. Failure of the dam would flood Interstate Route I-495 and a housing development and possibly cause the loss of a few lives. The dam is judged to be in poor condition. At the time of inspection brush growth was evident on the embankment.		

WILLIAMS LAKE DAM

MA 00451

MERRIMACK RIVER BASIN  
MARLBOROUGH, MASSACHUSETTS

PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM

Accession For	
NTIS GRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A/1	

DTIC  
COPY  
INSPECTED  
1

NATIONAL DAM INSPECTION PROGRAM  
PHASE I INSPECTION REPORT

Identification No.:	MA 00451
Name of Dam:	Williams Lake Dam
Town:	Marlborough
County and State:	Middlesex County, Massachusetts
Stream:	Millham Brook
Date of Inspection:	21 October 1980

BRIEF ASSESSMENT

Williams Lake Dam is an earth embankment dam with a downstream rubble masonry wall. The dam is about 183 ft. long and 6 ft. high. At each abutment there is a saddle whose low point is about 1 ft. below the crest of the embankment. The upstream slope of the embankment is about 3 horizontal to 1 vertical and the crest width of the dam is about 20 ft. The spillway for the dam is located about 65 ft. left of the right abutment and it is constructed of granite blocks. It has a broadcrested weir which is 3.5 ft. long. The crest is located 2 ft. below the top of the embankment. There is no low level outlet for the facility. The dam is used to impound water for municipal water supply purposes on a reserve standby basis.

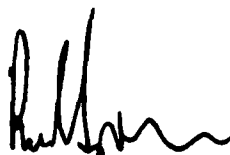
The lake is about 2,500 ft. long and the surface area of the lake is about 68 acres at spillway crest level. The drainage area above the dam is about 0.45 sq. mi. (288 acres). The maximum storage to top of the low points in the abutments is 320 acre-ft. The size classification is thus small. Failure of the dam would flood Interstate Route 495 and a housing development located about 1,300 ft. downstream of I-495 and possibly cause the loss of a few lives. Therefore, the dam has been classified as having a high hazard potential. Based on small size and high hazard, the range for the test flood is a  $\frac{1}{2}$  probable maximum flood ( $\frac{1}{2}$  PMF) to a full PMF. The selected test flood for the project is a  $\frac{1}{2}$  PMF.

The test flood inflow is 860 CFS; the routed test flood outflow of 290 CFS would overtop the low points in the abutments by 1.2 ft. and the top of the dam by 0.2 ft. The spillway can pass about 10 CFS or about 3 percent of the routed test flood outflow without overtopping the low points in the abutments.

The dam is judged to be in poor condition. At the time of the inspection brush growth was evident on the embankment, the downstream rubble masonry wall and the spillway walls were deteriorated, and seepage was noted on the downstream side of the spillway.

Within one year after receipt of this Phase I Inspection Report, the owner, the City of Marlborough, should retain the services of a registered professional engineer and implement the results of his evaluation of the following: (1) perform a detailed hydrologic and hydraulic analysis to further assess the need for and means to increase the project discharge capacity; (2) evaluate the feasibility of raising the embankment and the saddles at the abutments; (3) design and construct a means to drain the lake; (4) investigate the seepage at the toe of the spillway; (5) develop a plan for phased removal of trees including their root system from the embankment and within 10 ft. of the downstream toe and back filling with suitable compacted material; and (6) investigate the adequacy of the riprap on the upstream slope of the dam.

The owner should also carry out the following operational and maintenance procedures: (1) replace the dislodged stone in the spillway channel; (2) repair the downstream masonry wall; (3) develop a formal surveillance and downstream emergency warning plan, including round-the-clock monitoring during periods of heavy precipitation; (4) institute procedures for an annual technical inspection of the dam and its appurtenant structures; (5) immediately remove all brush and debris from the dam and spillway, and within 10 ft. of the downstream toe; and (6) implement a regular periodic maintenance program.

  
\_\_\_\_\_  
Peter B. Dyson  
Project Manager





## PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, sub-surface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

## TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
Letter of Transmittal	-
Brief Assessment	
Review Board Page	
Preface	i
Table of Contents	ii
Overview Photo	v
Location Map	vi

## REPORT

### 1. PROJECT INFORMATION

1.1 General	1
a. Authority	1
b. Purpose of Inspection	1
1.2 Description of Project	1
a. Location	1
b. Description of Dam and Appurtenances	1
c. Size Classification	2
d. Hazard Classification	2
e. Ownership	3
f. Operator	3
g. Purpose of Dam	3
h. Design and Construction History	3
i. Normal Operational Procedure	3
1.3 Pertinent Data	3

### 2. ENGINEERING DATA

2.1 Design Data	7
2.2 Construction Data	7
2.3 Operation Data	7
2.4 Evaluation of Data	7

<u>ection</u>	<u>Page</u>
. VISUAL INSPECTION	
3.1 Findings	8
a. General	8
b. Dam	8
c. Appurtenant Structures	8
d. Reservoir Area	9
e. Downstream Channel	9
3.2 Evaluation	9
4. OPERATIONAL AND MAINTENANCE PROCEDURES	
4.1 Operational Procedures	10
a. General	10
b. Description of any Warning System in Effect	10
4.2 Maintenance Procedures	10
a. General	10
b. Operating Facilities	10
4.3 Evaluation	10
5. EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES	
5.1 General	11
5.2 Design Data	11
5.3 Experience Data	11
5.4 Test Flood Analysis	11
5.5 Dam Failure Analysis	12
6. EVALUATION OF STRUCTURAL STABILITY	
6.1 Visual Observation	14
6.2 Design and Construction Data	14
6.3 Post-Construction Changes	14
6.4 Seismic Stability	14

<u>Section</u>	<u>Page</u>
7. ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES	
7.1 Dam Assessment	15
a. Condition	15
b. Adequacy of Information	15
c. Urgency	15
7.2 Recommendations	15
7.3 Remedial Measures	16
a. Operation and Maintenance Procedures	16
7.4 Alternatives	16

#### APPENDIXES

APPENDIX A - INSPECTION CHECKLIST

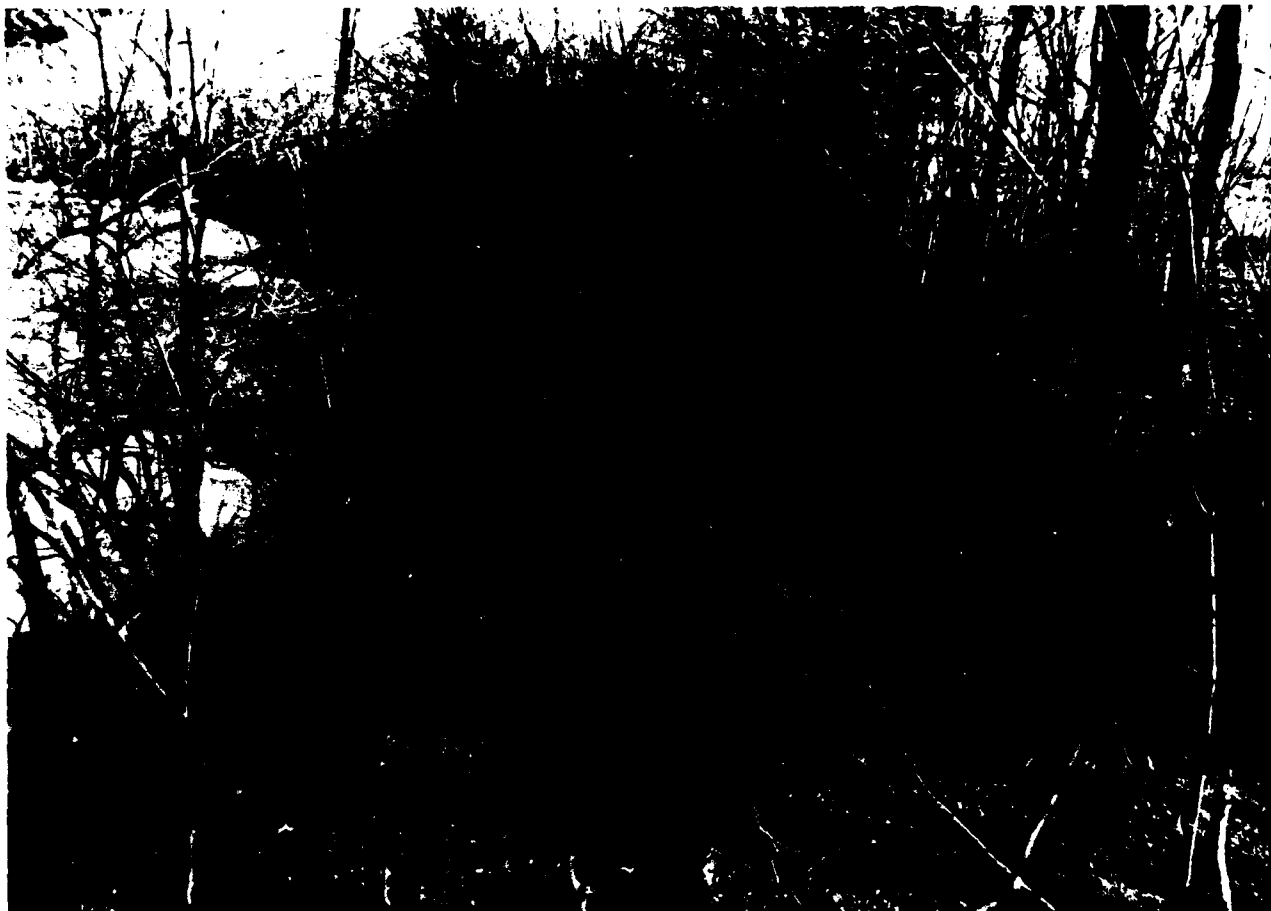
APPENDIX B - ENGINEERING DATA

APPENDIX C - PHOTOGRAPHS

APPENDIX D - HYDROLOGIC AND HYDRAULIC COMPUTATIONS

APPENDIX E - INFORMATION AS CONTAINED IN THE NATIONAL  
INVENTORY OF DAMS

WILLIAMS LAKE DAM



OVERVIEW PHOTOGRAPH



## SECTION 6 - EVALUATION OF STRUCTURAL STABILITY

### 6.1 Visual Observations

The Lake Williams Dam is in poor condition at the present time as revealed by the field inspection of October 21, 1980. There are several items of a remedial nature which were observed during the field visit and which will require treatment as outlined in Section 7. There are also deficiencies of a potentially more serious nature which will require the services of a registered professional engineer as outlined in Section 7.

### 6.2 Design and Construction Data

No definitive plans of the embankment, spillway, and rubble masonry wall are available. Data on the physical characteristics of the embankment materials are lacking. Calculations pertaining to the stability of the rubble masonry wall are lacking.

### 6.3 Postconstruction Changes

There are no records of any postconstruction changes made to the dam or the spillway over the course of its history.

### 6.4 Seismic Stability

The dam is in seismic zone number 2 and, in accordance with recommended Phase I guidelines, does not warrant seismic analysis.

The "rule of thumb" method suggested in the New England Division Corps of Engineers March 1978 Guidance Report was used for the breach analysis. With a breach width of 40 percent of the embankment length at mid height equal to 40 ft., an outflow of about 1,140 CFS, which includes 30 CFS through the spillway and 150 CFS through the saddles would be realized, (see sheets D-13 thru D-17, Appendix D).

The breach outflows from the dam will flow down Millham Brook to the Assabet River located about 2.6 miles downstream. In the 1,400 ft. reach below the dam the outflow travels along a small brook characterized by a 1 to 5 ft. dia. pipe culvert located under Interstate Route 495. It is estimated the breach discharge will only be reduced to about 1100 CFS at this point and I-495 will be overtopped by about 2 ft. of water. Under the prefailure conditions it is estimated the I-495 culvert will pass the pre-failure flows without overtopping the roadway. About 1,300 ft. beyond Interstate Route 495 Millham Brook enters into a closed drainage system as it passes under part of a housing development for a distance of about 1,600 ft. The entrance to the closed drainage system is a 30 in. circular pipe with very little freeboard. It is estimated the breach discharge will flow through the housing development flooding streets and about 20 houses to depths of 2 ft. It is estimated the flooding of all homes will be confined to below sill elevations resulting in only basement flooding. For the prefailure conditions it is estimated there will be street flooding to depths of about six inches. It is estimated there will be no further significant flooding beyond the housing development. About 1.3 miles below the housing development the brook enters Millham Reservoir and shortly thereafter the Assabet River.

In summary it is estimated a breach of the dam could cause appreciable economic losses, therefore, in accordance with the Recommended Guidelines for Safety Inspection of Dams the dam has been classified as having a high hazard potential. Sheet D-18, Appendix D, shows the area of initial impact.



Precipitation data was obtained from Hydrometeorological Report NO. 51, which for this area of Massachusetts is about 25 in. of 6 hour maximum rainfall over a 10 square mile area. This value was then reduced by 20 percent to allow for basin size, shape and fit factors and further reduced by 0.4 in. for infiltration losses. The six hour rainfall was distributed into one hour incremental periods as suggested in the Corps of Engineer's Publication EC 1110-2-1411.

A triangular incremental unitgraph was assumed for the inflow hydrographs, using a computed lag time value of 1.74 hours to derive a time-to-peak for a triangular hydrograph of 1.84 hours (see computations on Sheets D-6 thru D-8, Appendix D). A PMF inflow hydrograph is shown on Sheets D-9, Appendix D, indicating a peak inflow of about 1,720 cfs or a CSM of about 3,800. The peak inflow was divided by two to arrive at the test flood inflow value of 860 cfs.

Discharge tables and curves for the spillway and for over the top of the dam are shown on Sheets D-4 and D-5, Appendix D. For determining surface areas and surcharge capacities, planimetered areas were taken from contours delineated on 1:24,000 U.S.G.S. sheets.

A flood routing was performed for the test flood. Though the water surface level in the lake was 2.3 ft. below the spillway crest on the day of the inspection, for the purpose of this analysis the water surface was assumed to be at the spillway crest at the start of the routing. The results of this routing are shown on sheets D-11 thru D-12, Appendix D, and are summarized as follows:

<u>Test Flood Magnitude</u>	<u>Maximum Inflow cfs</u>	<u>Max. Res. Elev.</u>	<u>Maximum Head Over Embankment</u>	<u>Max. Head Over Low Point Lt. Rt. Abuts.</u>	<u>Max. Routed Test Flood Outflow cfs</u>
1/2 PMF	860	436.2 ft.	0.2 ft.	1.2 ft.	290

From the above table, it can be seen that the project will not pass the routed test flood outflow without overtopping the low point at the left and right abutments by 1.2 ft. and the crest of the dam by 0.2 ft. The spillway can only handle about 3 percent of the routed test flood without overtopping the low points in the left and right abutment.

#### 5.5 Dam Failure Analysis.

A breach owing to structural failure of the dam by piping or sloughing is a possibility. For this analysis a breach was assumed with the water level in the lake at the crest of the embankment.

## SECTION 5 - EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

### 5.1 General.

Williams Lake Dam is a rubble faced stone wall dam with an upstream earth embankment. There are saddles in the natural ground at each abutment which are about 1 ft. lower than the crest of the embankment. The dam impounds a normal storage of about 250 acre-ft. with provisions for an additional 69 acre-ft. in its surcharge space to the low point in the saddles and 140 acre-ft. in its surcharge space to the top of the earth embankment. The dam is basically a low surcharge-low spillage facility used to impound water for municipal water supply purposes on a reserve standby basis. The depth of the lake is reported to be about 10 ft. which would indicate there was a smaller natural impoundment at the site prior to the time the dam was built. With the lake water surface level at the top of the earth embankment the spillway discharges about 30 CFS. With the water level at that elevation a total of about 150 CFS would be spilling through the saddles at the abutments.

The general characteristics of the 0.45 sq. mi. (288 acres) drainage area is best described as rolling terrain, which rises from elevation 434 at spillway crest level to elevation 590. The drainage area predominately consists of open fields but there is a heavily urbanized area in the northeast sector.

### 5.2 Design Data

No hydrologic computations or hydraulic data has been recovered for the dam.

### 5.3 Experience Data

No records are available in regard to past operation of the reservoir, nor of surcharge encroachments and flows through the spillway. The maximum past outflows are unknown. It was reported by the owner's representatives that to their knowledge the dam had never been overtopped.

### 5.4 Test Flood Analysis

Hydrologic characteristics of Williams Lake Dam and drainage area were evaluated in accordance with criteria given in Recommended Guidelines for Safety Inspection of Dams. As indicated in Section 1.2, paragraphs c and d, Williams Lake Dam is classified as small in size with a high hazard potential. The recommended test flood for hydraulic evaluation of such a dam ranges from a half probable maximum flood, ( $\frac{1}{2}$  PMF) to a full PMF. Because a housing development is located about 2,700 ft. downstream a test flood equal to a  $\frac{1}{2}$  PMF was selected.

## SECTION 4 - OPERATIONAL AND MAINTENANCE PROCEDURES

### 4.1 Operation Procedures

a. General. The dam is owned and operated by the City of Marlborough. It is used to impound water for municipal water supply purposes. Water is pumped from the lake through a pumping station located on the north shore of the lake. There is no low level outlet at the facility and the spillway has no controls, stoplogs or flashboards. The dam is visited about once per year.

b. Description of any Warning System in Effect. No warning system is in effect at Williams Lake.

### 4.2 Maintenance Procedures

a. General. There is no documented regular periodic maintenance program in effect at Williams Lake Dam. There are, however, several items which require periodic maintenance, such as: the removal of debris from the crest of the spillway; the repair of the spillway training walls; the removal of trees and brush from the earth embankment; and the surveillance of the downstream wall regarding seeps.

b. Operating Facilities. There are no operating facilities at the dam.

### 4.3 Evaluation

Overall maintenance of the dam is generally poor. Specific maintenance items are evaluated as follows: Brush and tree growth has not been cleared on the embankment; the spillway is in a deteriorated condition; the downstream rubble masonry wall is deteriorating; and the spillway had not been cleared of debris. A regular periodic maintenance program should be implemented. The owner should also establish a formal downstream warning system for the dam in the event of an emergency.

There is no low level outlet at the dam or other appurtenant structures.

d. Reservoir Area. The shorelines upstream of the dam on both the right and left abutments appear stable with no evidence of landslides or sloughing. U. S. Route 20 passes along the northern rim of the lake and a pumping station used to pump water from the lake is located on the northern rim.

e. Downstream Channel. The spillway discharges into a small brook known as Millham Brook which joins the Assabet River about 2.6 miles below the dam. About 1,400 ft. below the dam the brook flows under Interstate Route 495 through a 5 ft. dia. concrete pipe. About 2,700 ft. below the dam the conveyance capacity of the brook becomes severely restricted as the brook flows under a housing development and through a closed drainage system for a distance of about 1,600 ft. At the entrance of the closed system there is a 30 in. dia. pipe with very little allowable headwater height. About 1.4 miles below the housing development the brook enters the Millham Reservoir which has a surface area about equal to that of Williams Lake. About 400 ft. downstream of the Millham Reservoir flows enter the the Assabet River.

### 3.2 Evaluation

The visual inspection adequately revealed key characteristics of the dam as they may relate to its stability and integrity. The dam and appurtenant works were judged to be in poor physical condition. There is heavy brush and tree growth on the dam. The spillway is in a deteriorated condition and the downstream rubble masonry wall has also deteriorated. Minor seepage was noted at the toe of the spillway. There is no low level outlet for the facility and there is no regular periodic maintenance program for the dam.

### SECTION 3 - VISUAL INSPECTION

#### 3.1 Findings

a. General. The visual inspection of Williams Lake Dam took place on 21 October 1980. On that date the water level in the lake was about 2.3 ft. below the crest of the spillway. Though no flow was passing over the spillway, seepage was noted at the downstream toe of the spillway and the stream bed just below the dam was wet. The spillway was in need of repair and brush and tree growth on the embankment was abundant. In general the dam was judged to be in poor physical condition.

b. Dam. Williams Lake Dam is an earth embankment structure with a downstream rubble masonry wall with uncemented joints constructed of field stones ranging in size from 1 to 2 ft. in diameter. The upstream slope of the dam is about 3 horizontal to 1 vertical and is covered with fieldstones generally from 1 to 2 ft. in diameter. The crest width of the embankment is about 20 ft. There are saddles at each abutment which have low points that are about 1 ft. lower than the crest of the dam. The saddle at the right abutment is about 55 ft. long and the saddle at the left abutment is about 72 ft. long.

Abundant brush and tree growth extends along the entire length of the dam. (see Appendix C, Photo Nos. 1 & 2). The downstream stone wall is tilting in the downstream direction and a section of the wall has moved outward and is essentially demolished (see Appendix C, Photo Nos. 3 & 4). At the time of the inspection, there was no seepage observed along the downstream toe of the wall area. The upstream slope of the dam is irregular and and overgrown with trees. The crest of the dam shows signs of trespassing as there is a footpath which passes along the entire length of the dam.

c. Appurtenant Structures. The spillway for the dam is located about 65 ft. left of the right abutment. It is of granite block construction and has a broadcrested wier which is 3.5 ft. long. The training walls are constructed of granite and extend 2 ft. above the spillway crest to the top of the embankment. The spillway is in poor condition, shows no sign of recent maintenance and is full of debris. A granite block has dislodged from the right spillway training wall and has fallen into the spillway channel. Debris has collected downstream of the weir (see Appendix C Photo No. 5). Though no seepage was noted downstream of the embankment area, a minor amount of clear seepage, estimated to be less than 1 gpm, was issuing through and beneath the spillway.

## SECTION 2 - ENGINEERING DATA

### 2.1 Design Data

No data on the design of the dam or appurtenances was available. In the course of the inspection, measurements were taken and a sketch plan and profile layout of Williams Lake Dam has been prepared, and is included in Appendix B.

### 2.2 Construction Data

No records or correspondence have been found regarding construction data.

### 2.3 Operation Data

No engineering operational data were disclosed.

### 2.4 Evaluation of Data

a. Availability. There was no engineering data available. The basis of the evaluation presented in this report is principally the visual observations of the inspection team.

b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgement.

c. Validity. Not applicable.

- (7) Impervious core - Unknown
- (8) Cutoff - Unknown
- (9) Grout curtain - Unknown
- h. Diversion and Regulating Tunnel - Not applicable
- i. Spillway
  - (1) Type - Broadcrested, granite block
  - (2) Length of weir - 3.5 ft.
  - (3) Crest elevation - 434.0
  - (4) Gates - None
  - (5) U/S Channel - Short granite block channel
  - (6) D/S Channel - Natural channel in earth
- j. Regulating Outlets - Not applicable

d. Reservoir (Length in feet)

- (1) Normal pool - 2,500
- (2) Flood control pool - Not applicable
- (3) Spillway crest pool - 2,500
- (4) Top of dam - 2,500
- (5) Test flood pool - 2,500

e. Storage (acre-ft.)

- (1) Normal pool -250
- (2) Flood control pool - Not applicable
- (3) Spillway crest pool - 250
- (4) Low point in saddles - 320
- (5) Top of dam - 390
- (6) Test flood pool -405

f. Reservoir Surface (acres)

- (1) Normal pool - 68
- (2) Flood-control pool - Not applicable
- (3) Spillway crest - 68
- (4) Low point in saddles - 69.7
- (5) Top of dam - 71.6
- (6) Test flood pool --71.9

g. Dam

- (1) Type - Stone wall with upstream earth embankment
- (2) Length - 183 ft.
- (3) Height - 6 ft.
- (4) Top width - 20 ft.
- (5) Side slopes - Downstream: vertical  
Upstream: 3 horizontal to 1 vertical
- (6) Zoning - Unknown



(2) Maximum Known Flood at Damsite. No records are available of flood inflows into Williams Lake, nor of spillway releases and surcharge heads during such inflows.

(3) Ungated Spillway Capacity at Top of Dam. The ungated spillway capacity is 10 CFS when the water level is at the low points in the saddles at the left and right abutments, elev. 435 and 15 CFS when the water level is at elev. 436.

(4) Ungated Spillway Capacity at Test Flood Elevation. The ungated spillway capacity at test flood elevation 436.2 is 34 CFS.

(5) Gated Spillway Capacity at Normal Pool Elevation. Not applicable.

(6) Gated Spillway Capacity at Test Flood Elevation. Not applicable

(7) Total Spillway Capacity at Test Flood Elevation. The total spillway discharge at the test flood elevation is the same as (4) above, 34 cfs at test flood elevation 436.2.

(8) Total Project Discharge at Top of Dam. The total project discharge is the same as (3) above 10 CFS when the water surface level is at the low points in the saddles at the left and right abutment, elev. 435, and 190 CFS when the water level is at top of dam elev. 436.

(9) Total Project Discharge at Test Flood Elevation. The total project discharge at test flood is 290 cfs at elevation 436.2.

c. Elevation (ft. N.G.V.D.)

- (1) Streambed at toe of dam - 430.0
- (2) Bottom of cutoff - Unknown
- (3) Maximum tailwater - Unknown
- (4) Normal pool - 434.0
- (5) Full flood control pool - Not applicable
- (6) Spillway crest - 434.0
- (7) Design surcharge (Original Design ) - Unknown
- (8) Top of dam - 436.0
- (9) Low point in saddles - 435.0 <sup>+</sup>
- (10) Test flood surcharge - 436.2

flooding of the homes is estimated to be at an elevation below sill elevation. It is estimated under the prefailure condition Interstate Route 495 will not be overtopped, but there will be flooding in the housing development streets to a depth of about 6 inches. In this area of initial impact is is considered there is the potential for appreciable economic loss and the possibility of the loss of a few lives. In accordance with the Recommended Guidelines for Safety Inspection of Dams, Williams Lake Dam has therefore been classified as having a high hazard potential.

e. Ownership. Williams Lake Dam is owned by the City of Marlborough, 860 Boston Post Road, Marlborough MA 01752. Telephone: 617-485-1755.

f. Operator. Mr. John Hartley, City of Marlborough, East Waste Water Treatment Plant, 860 Boston Post Road, Marlborough, MA 01752, Telephone: 617-485-1755.

g. Purpose of Dam. The dam impounds a body of water used as a municipal water supply for the City of Marlborough, MA. on a reserve standby basis. Water is pumped from the lake to a treatment plant and then distributed throughout the City.

h. Design and Construction History. It is not known by whom the dam was designed or constructed. It is believed the dam was constructed in 1882 to increase the impoundment capacity of Williams Lake.

i. Normal Operating Procedures. There is no low level outlet for the dam, nor is the spillway equipped with stoplogs or flashboards. According to the owner's representative the dam is visited about once per year by City personnel.

### 1.3 Pertinent Data

a. Drainage Area. The drainage area contributing to Williams Lake is situated at the headwaters of Millham Brook which is tributary to the Assabet River. The drainage area encompasses a total of about 0.45 sq. mi. (288 acres). The lake has a surface area of 68 acres. The longest circuitous water course leading to the dam is about 5,000 ft. long with an elevation difference of about 116 ft., or at a slope of about 122 ft. per mile. The drainage area has a length of about 5,000 ft. and an average width of about 2,500 ft. The basin consists predominately of open fields with a heavily developed urban area in the northeast sector. Part of the Route 495 and Route 20 interchange is located in the western sector of the drainage area.

#### b. Discharge at Damsite

(1) Outlet Works Conduit. There is no low level outlet at the dam.

across a shallow valley at the outlet of Williams Lake. The bottom of the lake is believed to be lower than the toe of the dam. A saddle is located at each abutment. The low point in the saddles are about 1 ft. below the crest of the dam. The saddle at the right abutment is about 55 ft. long and the saddle on the left abutment is about 72 ft. long. The upstream slope of the earth embankment is about 3 horizontal to 1 vertical and is covered with fieldstones ranging in size from 2 inches to 12 inches. The downstream face of the dam is formed by a nearly vertical rubble masonry wall built of rounded fieldstones generally from one to two feet in diameter. The wall has no mortar in the joints. The crest of the dam is about 20 ft. wide.

(2) Spillway. The spillway for Williams Lake Dam is located about 65 ft. left of the right abutment. The spillway is constructed of granite blocks and has a granite block broad-crested weir. The length of the weir is 3.5 ft. and its crest is located 2 ft. below the top of the earth embankment. Granite blocks form the training walls of the spillway and extend to the top of the earth embankment.

There is no low level outlet or other appurtenant structures at the dam.

c. Size Classification. Williams Pond Dam has a hydraulic height of about 6 ft. above downstream river level, and impounds a normal storage of about 250 acre-ft. to spillway crest level and a maximum of about 320 acre-ft. to top of the low points at the abutments.

In accordance with the capacity criteria given in Recommended Guidelines for Safety Inspection of Dams, the project falls into the small category on the basis of height and capacity and is therefore classified accordingly. A small size dam is one which has a height less than 25 ft. and a storage capacity greater than 50 ac.-ft. but less than 1,000 ac.-ft.

d. Hazard Classification. A breach failure of Williams Lake Dam would release water down Millham Brook for a distance of about 2.6 miles into the Assabet River. About 1,400 ft. below the dam Millham Brook passes under Interstate Route 495 through a 5 ft. dia. pipe culvert. It is estimated the initial breach discharge of 1,140 CFS will be only reduced to about 1,110 CFS at the I-495 crossing and the roadway will be overtopped by about 2 ft. of water. About 2,700 ft. below the dam Millham Brook flows into a closed drainage system which passes under a housing development for a distance of about 1,600 ft. The waterway opening at the entrance of this closed system is a 30 in. dia. pipe with little freeboard. It is estimated the breach discharge at this point will be about 1080 CFS and the breach flow will spill into the housing development flooding several streets and about 20 homes to a depth of about 2 ft. All of the

## PHASE I INSPECTION REPORT

WILLIAMS LAKE DAM MA 00451

### SECTION 1 - PROJECT INFORMATION

#### 1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Louis Berger & Associates, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed was issued to Louis Berger & Associates, Inc. under a letter of 30 September 1980 from William E. Hodgson, Jr., Colonel, Corps of Engineers. Contract No. DACW33-80-C-0043, Job Change No. 1 has been assigned by the Corps of Engineers for this work.

#### b. Purpose of Inspection.

(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.

(3) Update, verify and complete the National Inventory of Dams.

#### 1.2 Description of Project

a. Location. Williams Lake Dam is located in Middlesex County in the City of Marlborough in Eastern Massachusetts. The pond is situated at the headwaters of Millham Brook about 2.6 miles upstream of the confluence of Millham Brook and the Assabet River. The dam is reached via Williams St. and is shown on U.S.G.S. Quadrangle, Marlborough, Mass. with coordinates approximately at N 42° 20' 09", W71° 34' 17".

#### b. Description of Dam and Appurtenances

(1) Description of Dam. Williams Lake Dam is a 6 ft. high, 183 ft. long, earth embankment dam. The dam is constructed

## SECTION 7

### ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

#### 7.1 Dam Assessment

a. Condition. On the basis of the Phase I visual examination, Williams Lake Dam is judged to be in poor condition. The deficiencies reveal that further investigations should be carried out and some remedial work is needed. The major concerns revealed by the Phase I investigation are that the spillway will only pass about 3 percent of the routed test flood without overtopping the low points in the abutments and that there is no low level outlet for the facility.

b. Adequacy of Information. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgement.

c. Urgency. The recommendations and remedial measures enumerated below should be implemented by the owner within one year after receipt of this Phase I Inspection Report.

#### 7.2 Recommendations

It is recommended that the owner, the City of Marlborough, should retain the services of a registered professional engineer experienced in the design of dams to make a thorough study of the following, and if proved necessary, appropriate remedial works should be designed and constructed:

- (1) Perform a detailed hydrologic and hydraulic analysis to further assess the need for a means to increase the project discharge capacity.
- (2) Determine the feasibility of raising the embankment and the low sections at the abutments to such elevation as may be determined from the study in (1) above.
- (3) Design and construct a means to drain the lake.
- (4) Investigate the seepage through and beneath the spillway.
- (5) Because of their proximity to the downstream masonry wall, develop a plan for phased removal of trees and brush growth including their root systems from the embankment and within 10 ft. of the downstream toe and backfilling with suitable compacted material.

(6) Investigate the adequacy of the riprap on the upstream slope.

### 7.3 Remedial Measures

#### a. Operation and Maintenance Measures

(1) Replace the dislodged stone in the spillway channel.

(2) Repair the downstream rubble masonry walls.

(3) Develop an "Emergency Action Plan" that will include an effective preplanned downstream warning system, locations of emergency equipment, materials and manpower, authorities to contact and potential areas that require evacuation. The plan will also include round-the-clock monitoring of the project during periods of heavy precipitation.

(4) Institute procedures for an annual technical inspection of the dam and its appurtenant structures.

(5) Immediately remove all brush and debris from dam and spillway, and within 10 ft. of downstream toe.

(6) Implement a regular periodic maintenance program.

### 7.4 Alternatives

There are no feasible alternatives to the above recommendations.

Appendix A  
Inspection Checklist

VISUAL INSPECTION CHECKLIST  
PARTY ORGANIZATION

PROJECT Williams Lake Dam DATE 21 October 1980  
 OWNER City of Marlborough, MA TIME 1:30 PM  
 WEATHER Misty/Cool  
 W.S. ELEV. 431.7 U.S.        DN.S.

INSPECTION PARTY

<u>A/E REPRESENTATIVSS</u>	<u>OWNER'S REPRESENTATIVES</u>
1. <u>Pasquale Corsetti</u>	6. <u>Roscoe Cheney</u>
2. <u>William Zoino</u>	7. <u>Philip Maurice</u>
3. <u>Carl Hoffman</u>	8. <u>                    </u>
4. <u>Roger Berry</u>	9. <u>                    </u>
5. <u>                    </u>	10. <u>                   </u>

PROJECT FEATURE	INSPECTED BY	REMARKS
1. <u>Hydrology</u>	<u>Roger Berry</u>	<u>LBA</u>
2. <u>Hydraulics/Structures</u>	<u>Carl Hoffman</u>	<u>LBA</u>
3. <u>Geotechnical</u>	<u>William Zoino</u>	<u>GZA</u>
4. <u>General Features</u>	<u>Pasquale Corsetti</u>	<u>LBA</u>
5. <u>                    </u>	<u>                    </u>	<u>                    </u>
6. <u>                    </u>	<u>                    </u>	<u>                    </u>
7. <u>                    </u>	<u>                    </u>	<u>                    </u>
8. <u>                    </u>	<u>                    </u>	<u>                    </u>
9. <u>                    </u>	<u>                    </u>	<u>                    </u>
10. <u>                   </u>	<u>                    </u>	<u>                    </u>

LBA - Louis Berger & Associates, Inc.  
 GZA - Goldberg-Zoino & Associates, Inc.



# PERIODIC INSPECTION CHECKLIST

PROJECT Lake Williams Dam DATE 21 October 1980

PROJECT FEATURE Embankment NAME W. S. Zoino

DISCIPLINE Geotechnical NAME \_\_\_\_\_

AREA EVALUATED	CONDITIONS
----------------	------------

## DIKE EMBANKMENT

Crest Elevation	436
Current Pool Elevation	2.3' below spillway crest
Maximum Impoundment to Date	Unknown
Surface Cracks	None
Pavement Condition	N/A
Movement or Settlement of Crest	None
Lateral Movement	Downstream rubble wall tilting downstream
Vertical Alignment	Irregular
Horizontal Alignment	Poor - tilting wall
Condition at Abutment and at Concrete Structures	Poor - spillway training walls partially dislodged
Indications of Movement of Structural Items on Slopes	Downstream rubble wall locally dislodged
Trespassing on Slopes	Minor
Vegetation of Slopes	Very heavy both up and downstream
Sloughing or Erosion of Slopes or Abutments	None
Rock Slop Protection - Riprap Failures	Fair, small size 2" to 12"
Unusual Movement or Cracking at or near Toes	None
Unusual Embankment or Downstream Seepage	Minor seepage below spillway less than 1 GPM
Piping or Boils	None
Foundation Drainage Features	None
Toe Drains	None
Instrumentation System	None

# PERIODIC INSPECTION CHECKLIST

PROJECT Williams Lake Dam DATE 21 October 1980

PROJECT FEATURE Spillway NAME \_\_\_\_\_

DISCIPLINE Hydraulics/Structures NAME Carl Hoffman

AREA EVALUATED	CONDITIONS
----------------	------------

## OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS

### a. Approach Channel

General Condition	Poor
Loose Rock Overhanging Channel	Granite blocks loose
Trees Overhanging Channel	Yes
Floor of Approach Channel	Irregular granite blocks

### b. Weir and Training Walls

General Condition of Concrete	Granite blocks construction (poor)
Rust or Staining	N/A
Spalling	N/A
Any Visible Reinforcing	N/A
Any Seepage or Efflorescence	Seepage at downstream toe
Drain Holes	N/A

### c. Discharge Channel

General Condition	Fair
Loose Rock Overhanging Channel	No
Trees Overhanging Channel	Yes
Floor of Channel	Natural ground
Other Obstructions	

# PERIODIC INSPECTION CHECKLIST

PROJECT Williams Lake Dam DATE 21 October 1980

PROJECT FEATURE \_\_\_\_\_ NAME \_\_\_\_\_

DISCIPLINE \_\_\_\_\_ NAME \_\_\_\_\_

AREA EVALUATED	CONDITIONS
----------------	------------

Dike Embankment	N/A
-----------------	-----

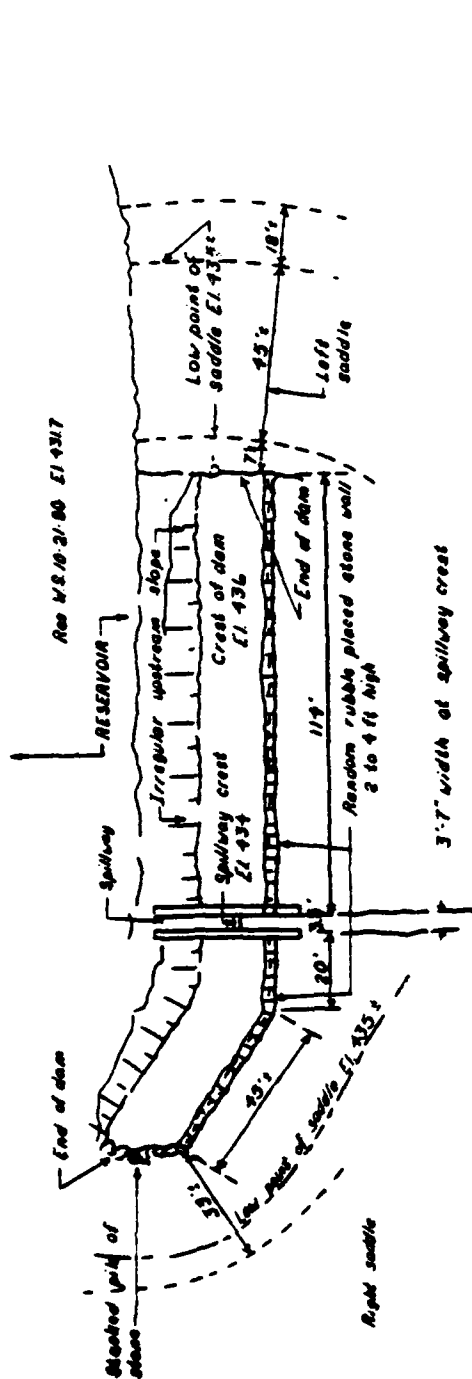
Outlet Works - Intake Channel and Intake Structure	N/A
---	-----

Outlet Works - Transition and Conduit	N/A
---------------------------------------	-----

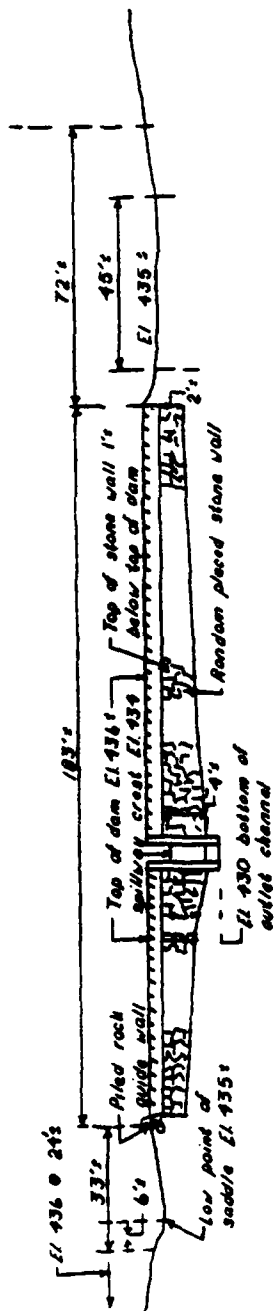
Outlet Works - Control Tower	N/A
------------------------------	-----

Outlet Works - Service Bridge	N/A
-------------------------------	-----

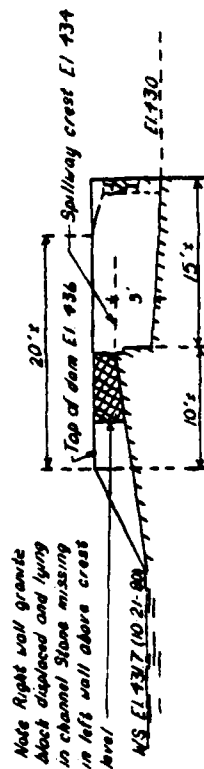
**Appendix B**  
**Engineering Data**



**PLAN**



**PROFILE ALONG DAM CREST**



**SECTION THRU SPILLWAY**

**WILLIAMS LAKE DAM  
MARLBOROUGH  
PLAN AND PROFILES**

INSPECTION REPORT - DAMS AND RESERVOIRS

(1.) Location: City/Town MARLBOROUGH

Dam No. 4-9-170-6

Name of Dam LAKE WILLIAMS DAM

Inspected by A. Z. PIZAN

F. H. PARE  
Date of Inspection 7-25-7

(2) Owners: per: Assessors ✓ Prev. Inspection \_\_\_\_\_

Reg. of Deeds \_\_\_\_\_ Pers. Contact \_\_\_\_\_

1. CITY OF MARLBOROUGH, DEPT. PUBL. WKS, NEIL ST. 485-0392

Name St. & No. City/Town State Tel. No.  
MARLBORO, MASS. 01752

2. \_\_\_\_\_  
Name St. & No. City/Town State Tel. No.

3. \_\_\_\_\_  
Name St. & No. City/Town State Tel. No.

(3) Caretaker: (if any) e.g. superintendent, plant manager, appointed by  
absentee owner, appointed by multi owners.

SAME

Name St. & No. City/Town State Tel. No.

(4) No. of Pictures taken NONE

(5) Degree of Hazard: (if dam should fail completely)\*

1. Minor ✓ 2. Moderate \_\_\_\_\_

3. Severe \_\_\_\_\_ 4. Disastrous \_\_\_\_\_

\*This rating may change as land use changes (future development)

(6) Outlet Control: Automatic \_\_\_\_\_ Manual ✓

Operative ✓ yes: \_\_\_\_\_ no: \_\_\_\_\_

Comments: FLASHBOARDS CONTROLLED WHEN NECESSARY

(7) Upstream Face of Dam: Condition:

1. Good ✓ 2. Minor Repairs \_\_\_\_\_

3. Major Repairs \_\_\_\_\_ 4. Urgent Repairs \_\_\_\_\_

Comments: \_\_\_\_\_

B-2

Copy available to DTIC does not  
permit full reproduction

-2-

DAM NO. 4-9-170-6

Downstream Face of Dam: Condition: 1. Good ☒ 2. Minor Repairs \_\_\_\_\_  
3. Major Repairs \_\_\_\_\_ Urgent Repairs \_\_\_\_\_

Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Emergency Spillway: Condition: 1. Good ☒ 2. Minor Repairs \_\_\_\_\_  
3. Major Repairs \_\_\_\_\_ 4. Urgent Repairs \_\_\_\_\_

Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Water level @ time of inspection 2 ft. above \_\_\_\_\_ below ☒  
top of dam \_\_\_\_\_ Principal spillway ☒  
other \_\_\_\_\_

Summary of Deficiencies Noted:

Growth (Trees and Brush on Embankment) BRUSH ON EMBANKMENT  
Animal Burrows and Washouts \_\_\_\_\_  
Damage to slopes or top of dam \_\_\_\_\_  
Cracked or Damaged Masonry \_\_\_\_\_  
Evidence of Seepage \_\_\_\_\_  
Evidence of Piping \_\_\_\_\_  
Erosion \_\_\_\_\_  
Leaks \_\_\_\_\_  
Brush and/or debris impeding flow \_\_\_\_\_  
Clogged or blocked spillway \_\_\_\_\_  
Other \_\_\_\_\_

4-9-170-6

-3-

2) Remarks & Recommendations: (Fully Explain)

*DAM IS IN GOOD CONDITION.*

3) Overall Condition:

1. Safe ☒ \_\_\_\_\_
2. Minor repairs needed \_\_\_\_\_
3. Conditionally safe - major repairs needed \_\_\_\_\_
4. Unsafe \_\_\_\_\_
5. Reservoir impounded no longer exists (explain)  
Reservoir removed from inspection list \_\_\_\_\_

Copy available to DDC does not  
permit fully legible reproduction

B-4



DESCRIPTION OF DAM  
DISTRICT #4

dicted by FRANCIS H. PARE & ADAM Z. PIZANO Dam No. 4-9-170-6  
City/Town MARLBOROUGH 01752  
Name of Dam LAKE WILLIAMS DAM

Location: Topo Sheet No. 23 D  
Provide 8 1/2" x 11" in clear copy of topo map with location of Dam  
clearly indicated.

Year built: 1882 Year/s of subsequent repairs UNKNOWN

Purpose of Dam: Water Supply ☒ Recreational ☐  
Irrigation ☐ Other ☐

Drainage Area: 1 SQ. MI. 140 ACRES.

Normal Ponding Area: 72 acres; Ave Depth 10'  
Impoundment: 240 MIL gals; 720 acre ft.

No. and type of dwellings located adjacent to pond or reservoir  
i.e., summer homes etc. NONE

Dimensions of Dam: Length 195' Max. Height 5'  
Slopes: Upstream Face 3:1  
Downstream Face 2:1  
Width across top 30

Classifications of Dam by Materials:

Earth ☒ Stone Masonry ☒ Stone Masonry ☒  
Masonry ☐ Rockfill ☐ Other ☐

1. Description of present land usage downstream of dam: 80% rural  
20% urban  
2. Is there a flood plain or flood plain downstream of dam which could  
be inundated in the event of a dam failure?  
Yes ☒ No ☐

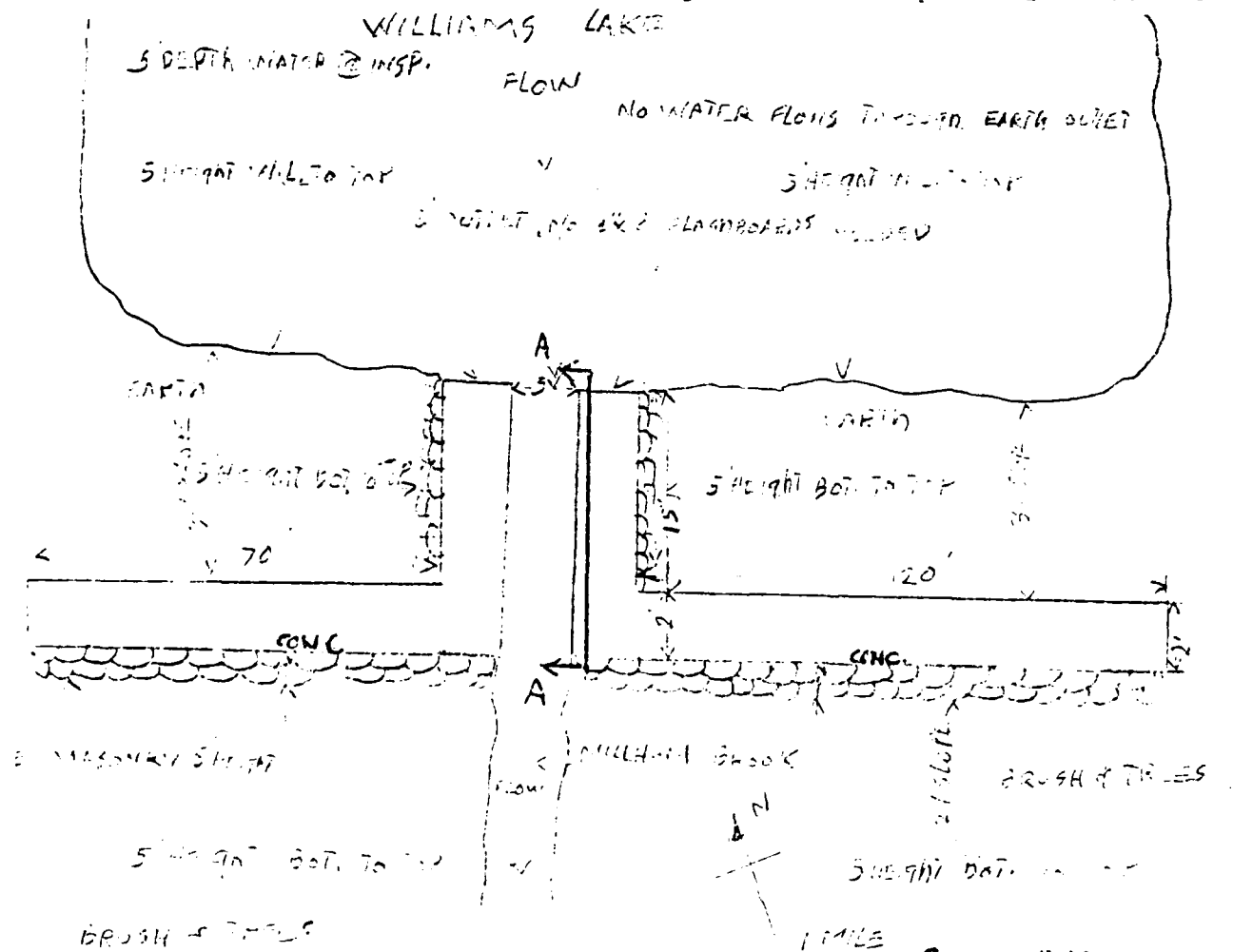
DAF NO. 4-9-170-6

risk to life and property in event of complete failure.

No. of people NONE  
No. of homes "  
No. of businesses "  
No. of industries "  
No. of utilities "  
Railroads NONE  
Other dams "  
Other \_\_\_\_\_

Type \_\_\_\_\_  
Type \_\_\_\_\_

Sketch of cut to S. s. road showing section and plan 3 1/2' x 11" Sheet.



Copy available to DTIC does not permit fully legible reproduction

TOP VIEW  
SKETCH NOT TO SCALE  
B-6

WILLIAMS. 52

RFB DATE 11-21-80 LOUIS BERGER & ASSOCIATES INC.

SHEET NO. 1 OF 3

KD. BY DATE

PROJECT W-175

SUBJECT WILLIAMS LAKE DAM, INFLOW HYDROGRAPH

DRAINAGE AREA = 0.45 sq. mi = 288 ACRES

RESERVOIR AREA = 68 ACRES < 25% D.A.

LENGTH OF LONGEST WATER PATH = 5,000 FT  
L = 0.95 MILES

ELEVATION DIFFERENCE = 550 - 434 = 116 FT

∴ SLOPE =  $\frac{116}{0.95} = 122 \text{ FT/MI} \text{ } \& \sqrt{S} = 11.05$

Now  $\frac{LLC}{\sqrt{S}} = \frac{(0.95)(0.95)}{2(11.05)} = 0.041$

$\left(\frac{LLC}{\sqrt{S}}\right)^{0.33} = (0.041)^{0.33} = 0.348$

$LAG = K \left(\frac{LLC}{\sqrt{S}}\right)^{0.33} = K(0.348)$

ASSUME K = 5.0 HRS

REFER TO "CURVE B" MOUNTAIN  
REGION, MIXED TERRAIN,  
BOB KEE

$LAG = 5.0(0.348) = 1.74 \text{ HOURS}$

$T_p = 0.41D + 0.82LAG$ , WHERE D = 1.0 HRS

$T_p = 0.41(1) + 0.82(1.74)$

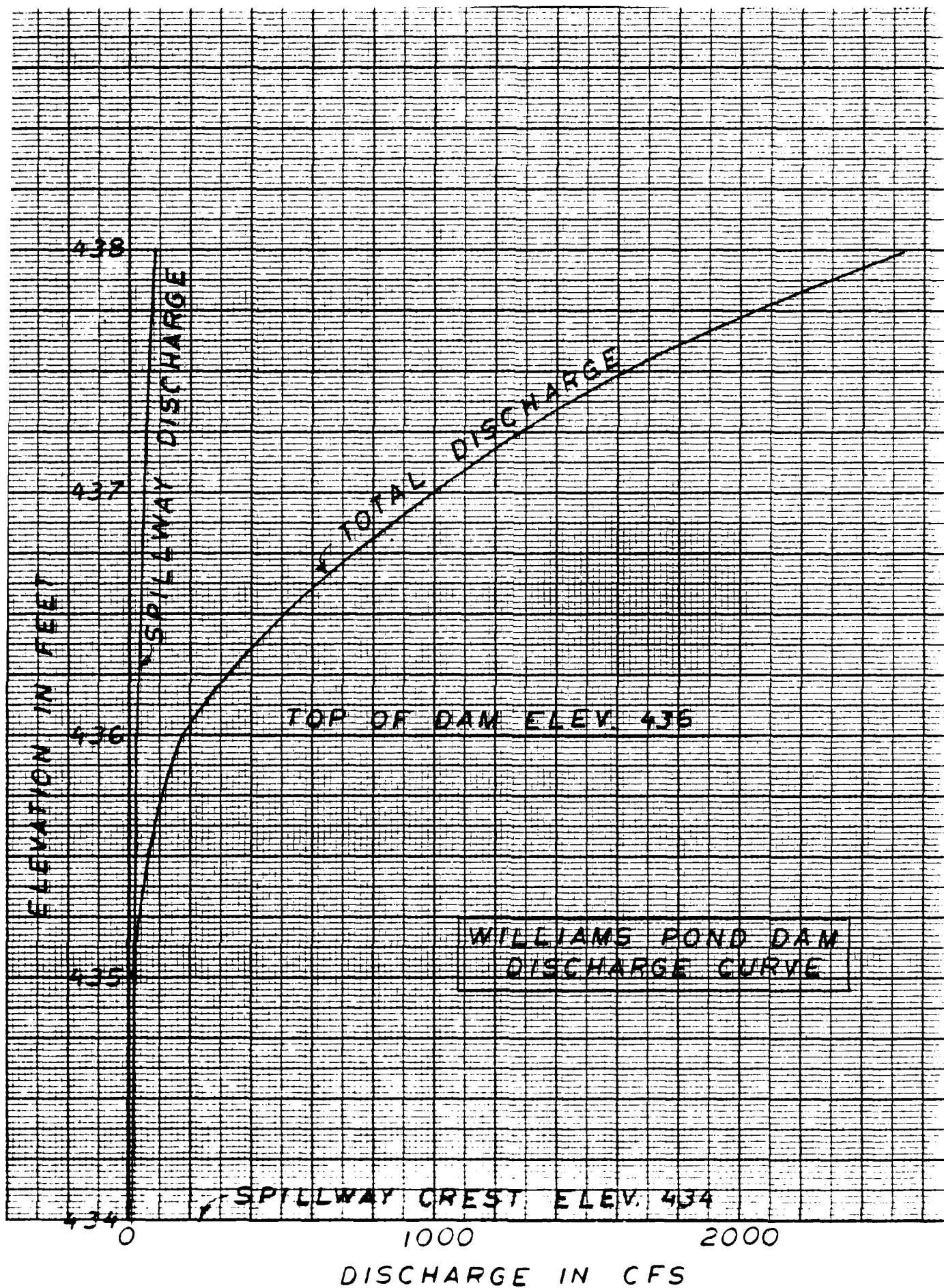
$T_p = 1.84 \text{ HRS}$

CHANNEL VELOCITY

$T_c = \frac{T_p - 0.5D}{0.6}$

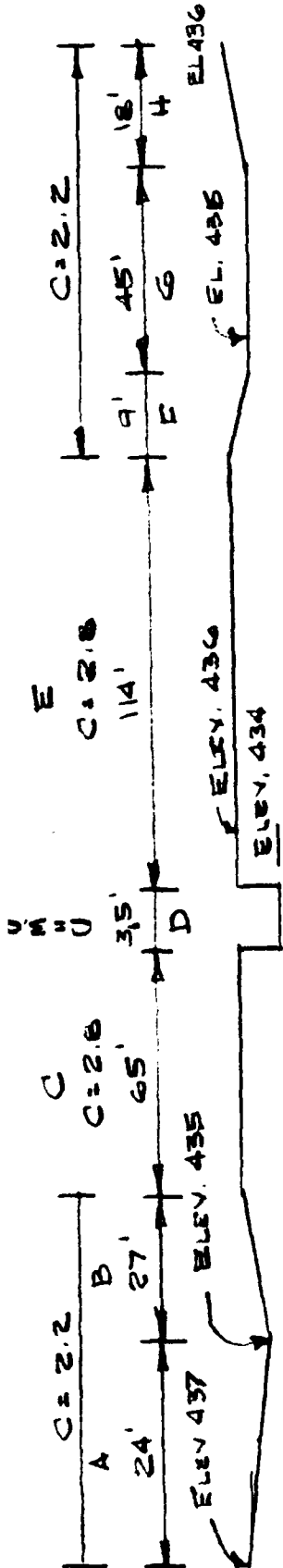
$T_c = \frac{1.84 - 0.5}{0.6} = 2.23 \text{ HRS}$

$V = \frac{5000}{2.23 \times 3600} = 0.62 \text{ FT/SEC} \text{ } \& K$



BY RFB DATE 11-24-80 LOUIS BERGER & ASSOCIATES INC.  
 CHKD. BY DATE  
 SUBJECT WILLIAMS POND

SHEET NO. 1 OF 1  
 PROJECT W-198



ELEV.	A+B		C+E		D		E+H		Q	
	H	L	H	L	H	L	H	L	H	L
434	0	-	0	0	0	3.5	0	-	0	0
435	0	-	0	0	0	1.5	0	-	0	0
435.5	.25	19.5	0	0	0	1.5	.25	14	.5	35
436	.5	39	0	0	2	2.5	.5	27	-	97
436.5	.75	45	.5	179	2.5	42	.75	1.5	1.5	182
437	1	51	1	179	3	54	1	1.25	2	280
437.5	1.25	51	1.5	179	3.5	64	1.25	3	2.5	341
438	1.5	51	2	179	4	84	1.5	3	3	514

ELEV.	ΣQ's
434	0
435	10
435.5	63
436	180
436.5	503
437	1007
437.5	1621
438	2331

AREA IN ACRES

60

70

80

TOTAL STORAGE IN ACRE-FT.

250

350

450

550

650

750

850

ELEVATION IN FEET

441

440

439

438

437

436

435

434

SURCHARGE & TOTAL STORAGE

AREA

TOP OF DAM EL. 436

WILLIAMS POND DAM  
RESERVOIR AREA &  
CAPACITY CURVES

SPILLWAY CREST EL. 434

0

1

2

3

4

5

6

SURCHARGE STORAGE IN AF X 10<sup>2</sup>

U.S. STANDARD CROSS SECTION  
10 X 10 TO THE HALF INCH

BY RFB DATE 11-24-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 2 OF       
 CHKD. BY      DATE      PROJECT W-198  
 SUBJECT WILLIAMS LAKE DAM STORAGE CAPACITY

NORMAL STORAGE: FROM OWNERS REPRESENTATIVES  
 LAKE IS ABOUT 10 FT DEEP

$$\text{STORAGE} = \frac{1}{2} hA = \frac{1}{2} 10 \text{ FT} (68A) \\ = 340 \text{ ACRES-FT}$$

FROM OLD COE INVENTORY:  $S = 185 \text{ AF.}$

SAY NORMAL STORAGE = 250 A.F.  
 @ ELEV. 434

ELEV.	AREA ACRES	AVE AREA	H	DV ACRES-FT	TOTAL STORAGE	SURCHARGE STORAGE
434	68				250	
435	69.8	68.9	↑ ↓	68.9	319	69
436	71.6	70.7		70.7	390	140
437	73.4	72.5		72.5	462	212
438	75.2	74.3		74.3	536	286
439	77	76.1		76.1	612	362
440	78.7	77.8		77.8	690	440
441	80.4	79.6		79.6	770	520

BY RFB DATE 10-6-30 **LOUIS BERGER & ASSOCIATES INC.**  
CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_  
SUBJECT WILLIAMS LAKE Hydrology

SHEET NO. 1 OF \_\_\_\_\_  
PROJECT W-198

FIND DRAINAGE AREA

SCALE: 1:24,000

READ #2 19.84  
" #1 16.73  
3.11

READ #3 22.96  
" #2 19.84  
3.12

AVE: 3.12

AREA =  $3.12 \times 0.1435 = 0.45$  sq mi

RESERVOIR SURFACE AREA: ELEV. 434

READ #2 28.47  
" #1 27.74  
0.73

READ #3 29.22  
" #2 28.47  
0.75

AVE: 0.74

AREA =  $0.74 \times 91.83 = 68$  ACRES

AREA ELEV 440

READ #2 30.20  
" #1 29.35  
0.85

READ #3 31.04  
" #2 30.20  
0.84

AVE: 0.84

AREA =  $0.84 \times 91.83 = 77$  ACRES

AREA ELEV. 450

READ #2 31.56  
" #1 30.56  
1.00

READ #3 32.61  
" #2 31.56  
1.05

AVE: 1.02

AREA =  $1.02 \times 91.83 = 94$  ACRES



**Appendix D**  
**Hydrologic and Hydraulic Computations**

WILLIAMS LAKE DAM



5. View of spillway from downstream toe of dam -  
note: debris and deteriorated condition.

WILLIAMS LAKE DAM



3. View of deteriorated downstream stone wall from right abutment.



4. View of deteriorated downstream stone wall from left abutment.

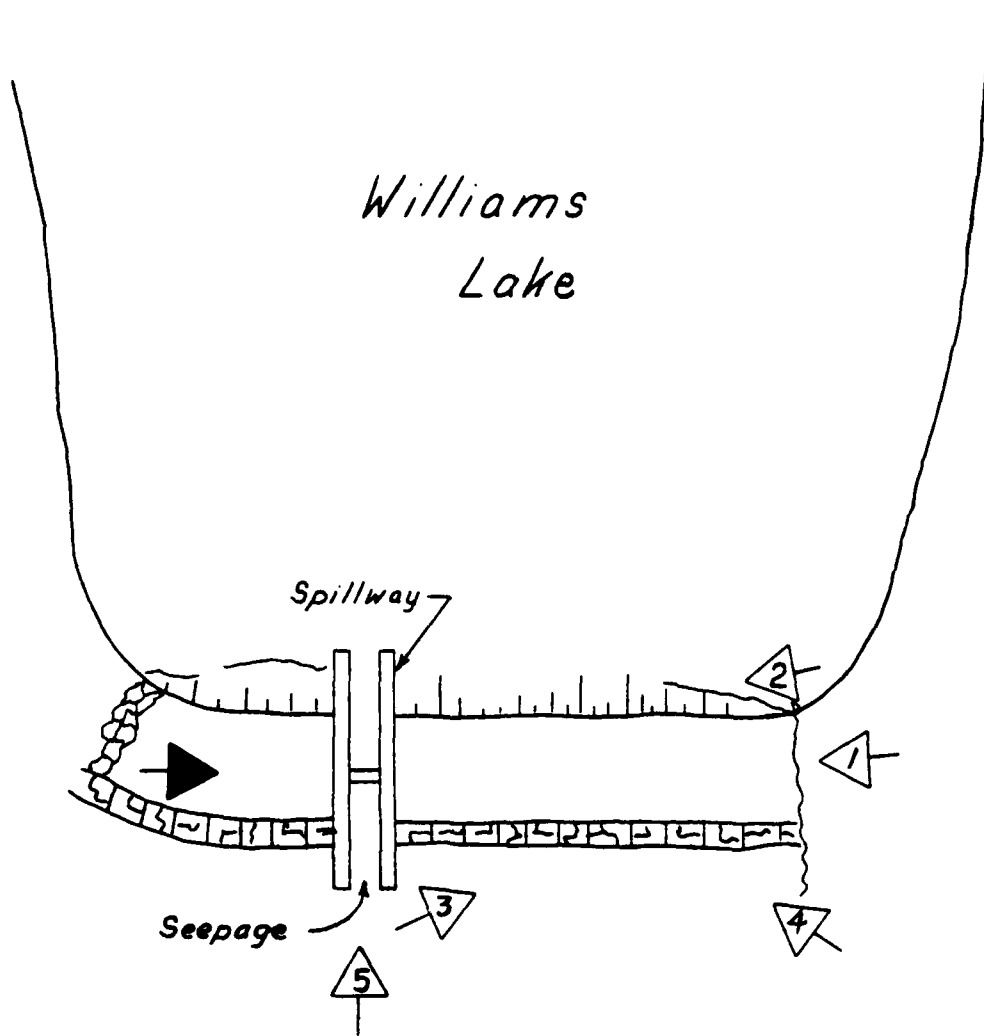
WILLIAMS LAKE DAM



1. Brush and tree growth along crest of dam.



2. Brush and tree growth on upstream slope.



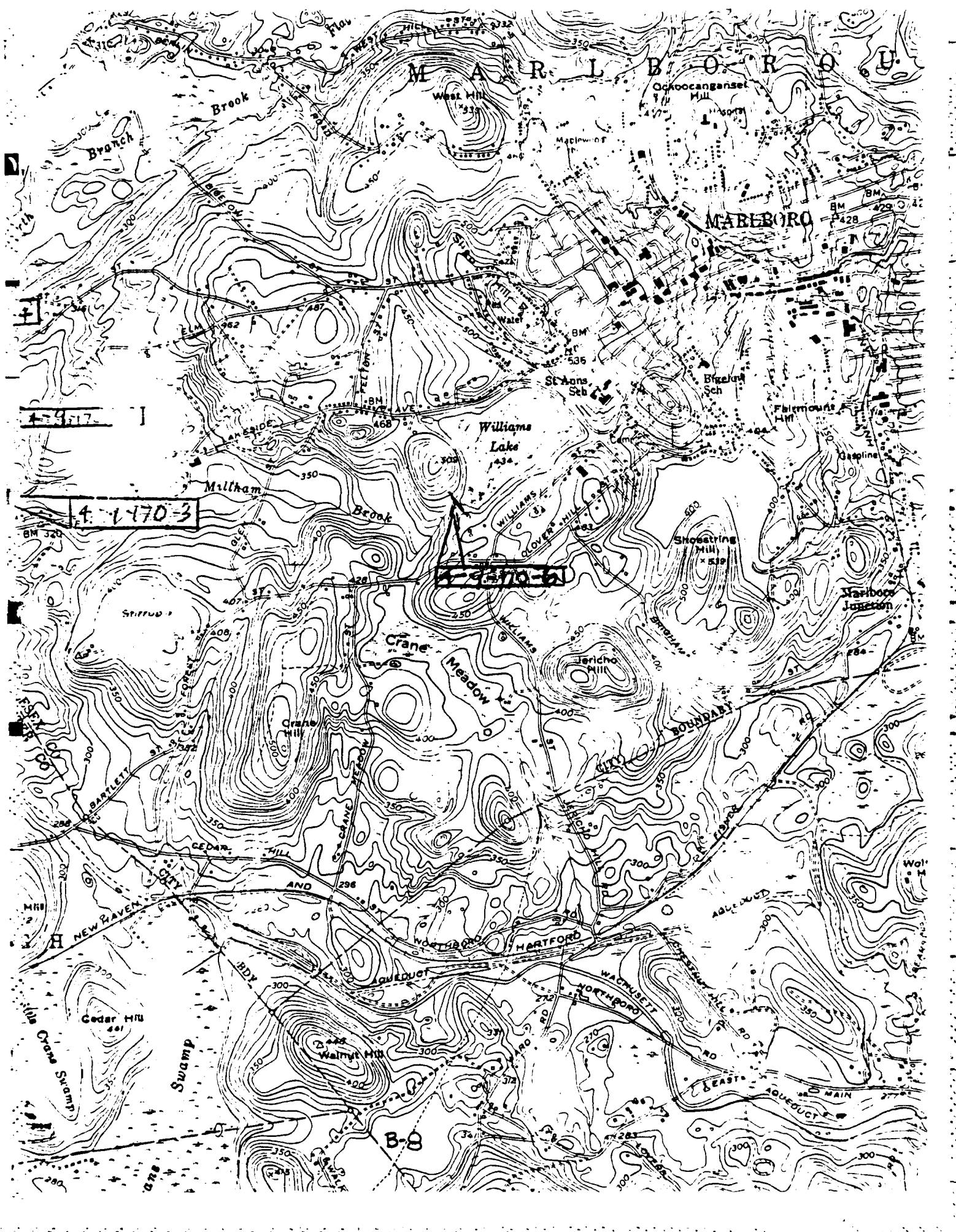
➡ Overview Photo  
➤ Appendix "C" Photo

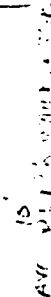
C-1

LOUIS BERGER & ASSOC., INC. WELLESLEY, MASS. ARCHITECT · ENGINEER		U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.	
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS			
WILLIAMS LAKE DAM			
SKETCH PLAN SHOWING LOCATION & ORIENTATION OF PHOTOS			
STATE - MA			
		SCALE NOT TO SCALE	
		DATE	

Appendix C

Photos





Copy available to DTIC does not permit fully legible reproduction



BY RFB DATE 11-21-80 LOUIS BERGER & ASSOCIATES INC.

SHEET NO. 2 OF 3

CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_

PROJECT W-198

SUBJECT WILLIAMS LAKE DAM INFLOW HYDROGRAPH

$$T_R = 1.67 T_P = 1.67 (1.84) = 3.07 \text{ HRS}$$

$$T_B = T_P + T_R = 1.84 + 3.07 = 4.91 \text{ HRS}$$

---

$Q_P$  = PEAK RATE IN CFS

$$Q_P = \frac{484 A Q}{T_P}$$

A = DRAINAGE AREA

Q = RAINFALL IN INCHES

$$Q_P = \frac{484 (0.45) (1)}{1.84} = 118 \text{ CFS}$$

---

PMP = PROBABLE MAXIMUM PRECIPITATION

$$= 25'' (0.8) = 20'' \text{ FOR MASSACHUSETTS}$$

$$= 19.6'' \text{ CONSIDERING INFILTRATION FOR OVERLAND FLOW.}$$

BY RFB DATE 11-21-80 LOUIS BERGER & ASSOCIATES INC.

SHEET NO. 3 OF 3

CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_

PROJECT W-198

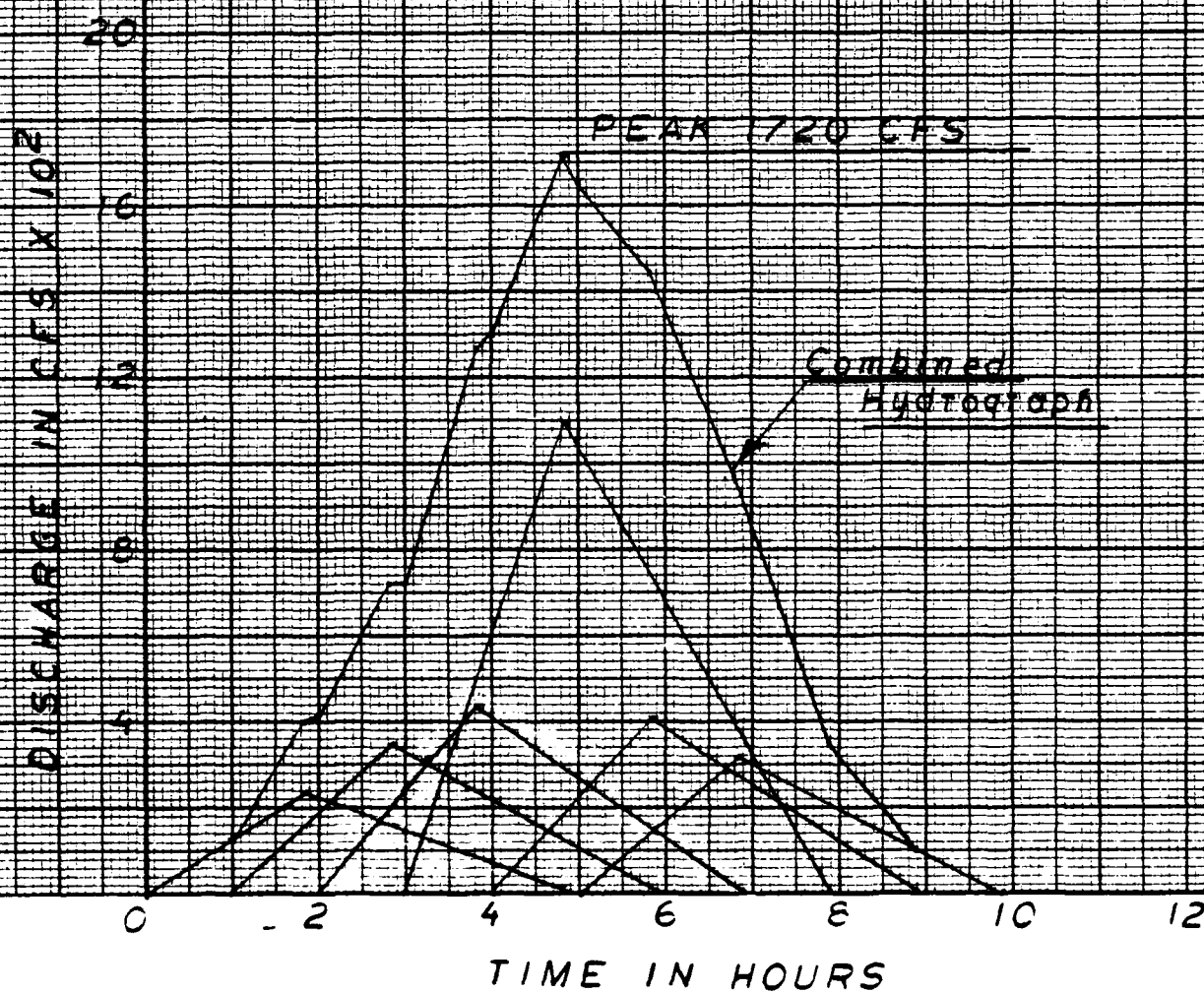
SUBJECT WILLIAMS LAKE DAM, INFLOW HYDRO

FLOOD HYDROGRAPH FOR PMF,  $q_p = 118$  cfs

TIME (HOURS)	%	INCHS	Qp cfs	BEGIN	PEAK	END
0.0	-					
1.0	10	1.96	231	0	1.84	4.91
2.0	12	2.35	345	1.0	2.84	5.91
3.0	15	2.94	432	2.0	3.84	6.91
4.0	38	7.45	1095	3.5	4.84	7.91
5.0	14	2.74	403	4.0	5.84	8.91
6.0	11	2.16	318	5.0	6.84	9.91

\* DISTRIBUTION OF MAXIMUM 6 HOUR PMP  
IN PERCENT OF 6 HOUR AMOUNT PER  
EM 1110-2-1411

WILLIAMS POND DAM  
FULL PMF  
INFLOW HYDROGRAPH



BY RFB DATE 11-24-80 LOUIS BERGER & ASSOCIATES INC.

SHEET NO. 1 OF 3

CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_

PROJECT W-198

SUBJECT WILLIAMS POND DAM, RESERVOIR ROUTING

DRAINAGE AREA = 0.45 sq. mi = 288 ACRES

MAXIMUM STORAGE = 390 ACRE-FT.

HEIGHT = 6 FT.

∴ SIZE CLASSIFICATION = SMALL

HAZARD CLASSIFICATION = SIGNIFICANT

OCE GUIDELINES, USE 100 YR  $\frac{1}{2}$  PMF

USE  $\frac{1}{2}$  PMF FOR TEST FLOOD

FROM INFLOW HYDROGRAPH ∴ PMF = 1,720 CFS

TEST FLOOD =  $\frac{1}{2}$  PMF = 860 CFS

---

STEP 1:  $Q_{P1} = 860$  CFS

STEP 2a: STAGE = 436.87

STEP 2b: SURCHARGE VOLUME = 203 ACRE-FT

$$\text{INCHS RUNOFF} = \frac{203 \text{ A.F.}}{288 \text{ ACRES}} \times 12 = 8.45 \text{ IN.}$$

$$\text{STEP 2c: } Q_{P2} = 860 \left(1 - \frac{8.45}{9.5}\right)$$

$$Q_{P2} = 95 \text{ CFS}$$

STEP 3a: FOR  $Q = 95$  CFS

SURCHARGE HEIGHT = 435.7

SURCHARGE VOL = 117 ACRE-FT

BY REB DATE 11-24-80 LOUIS BERGER & ASSOCIATES INC.

SHEET NO. 2 OF 3

CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_

PROJECT W-199

SUBJECT WILLIAMS POND DAM, RESERVOIR ROUTING

### STEP 3a (CONTINUED)

$$\text{INCHS RUNOFF} = \frac{117 \times 12}{288} = 4.88 \text{ INCHS}$$

### STEP 3b

$$\text{AVE STORAGE} = \frac{8.45 + 4.88}{2} = 6.665 \text{ IN.}$$

---

### 2ND ITERATION

$$\text{STEP 2c } Q_{P2} = 860 \left(1 - \frac{6.665}{9.5}\right)$$

$$Q_{P2} = 257 \text{ CFS}$$

$$\text{STEP 3a FOR } Q = 257 \text{ CFS}$$

$$\text{SURCHARGE HEIGHT} = 436.15$$

$$\text{SURCHARGE VOLUME} = 150 \text{ ACRE-FT.}$$

$$\text{INCHS RUNOFF} = \frac{150 \times 12}{288} = 6.25 \text{ INCHS}$$

$$\frac{\text{STOR}_1 + \text{STOR}_2}{2} = \frac{6.665 + 6.25}{2} = 6.46$$

---

### 3RD ITERATION

$$\text{STEP 2c } Q_{P2} = 860 \left(1 - \frac{6.46}{9.5}\right)$$

$$Q_{P2} = 275 \text{ CFS}$$

$$\text{STEP 3a FOR } Q = 275 \text{ CFS}$$

$$\text{SURCHARGE HEIGHT} = 436.175$$

BY RFB DATE 11-24-80 LOUIS BERGER & ASSOCIATES INC.

SHEET NO. 3 OF 3

CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_

PROJECT \_\_\_\_\_

SUBJECT WILLIAMS POND DAM

RESERVOIR ROUTING

### STEP 3a (CONTINUED)

$$\text{SURCHARGE VOL} = 152 \text{ A.F.}$$

$$\text{INCHS RUNOFF} = \frac{152 \times 12}{288} = 6.33 \text{ IN.}$$

$$\text{STEP 3b } \overline{\text{STOR}} = \frac{6.46 + 6.33}{2} = 6.40 \text{ IN.}$$

$$\text{SURCHARGE VOL} = \frac{6.40 \times 288}{12} = 154 \text{ A.F.}$$

$$\text{SURCHARGE HEIGHT} = 436.2 \text{ FT.}$$

$$Q_{P3} = 290 \text{ CFS.}$$

$\frac{1}{2}$  PMF OVERTOPS SADDLES BY  $436.2 - 435 = 1.2 \text{ FT}$

$\frac{1}{2}$  PMF OVERTOPS TOP OF DAM BY  $436.2 - 436 = 0.2 \text{ FT.}$

$$Q_{\text{OUT}} = 290 \text{ CFS}$$

BY RFB DATE 11-24-80 LOUIS BERGER & ASSOCIATES INC.

SHEET NO. 1 OF 5

CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_

PROJECT W-148

SUBJECT WILLIAMS LAKE DAM

FAILURE ANALYSIS

STEP 1: RESERVOIR ELEV. @ FAILURE = 436 FT

VOLUME RELEASED:  $S_1 \approx 150 + 6/10(250) = 300 \text{ A.F.}$

HEIGHT =  $Y_0 = 6 \text{ FT}$

$W = 40\% (\text{LENGTH AT MID HEIGHT}) = 0.4(100) = 40 \text{ FT}$

STEP 2: PEAK FAILURE

$$Q_{PI} = 8/27 W \sqrt{g} Y_0^{3/2}$$

$$Q_{PI} = 1.68(40)(6)^{3/2}$$

$$Q_{PI} = 988 \text{ CFS}$$

SPILLWAY  $Q = 30 \text{ CFS}$ , SADDLE  $Q = 150$

TOTAL  $Q_{PI} \approx 1140 \text{ CFS}$

REACH #1 DAM TO I-495 ( $L = 1400 \text{ FT}$ )

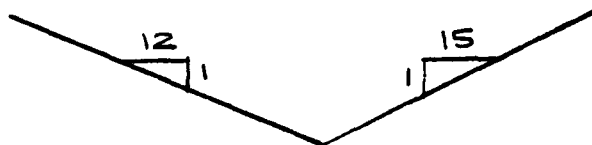
$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

$$Q = 2.39 A R^{2/3}$$

$$S = \frac{434 - 390}{1400} = 0.0314$$

$$S^{1/2} = 0.177$$

$$n = .110$$



STAGE	AREA	P	$R^{2/3}$	Q
2	54	54.15	1.0	129
3	122	81.22	1.31	382
4	216	108.30	1.58	816
5	338	135.4	1.84	1486

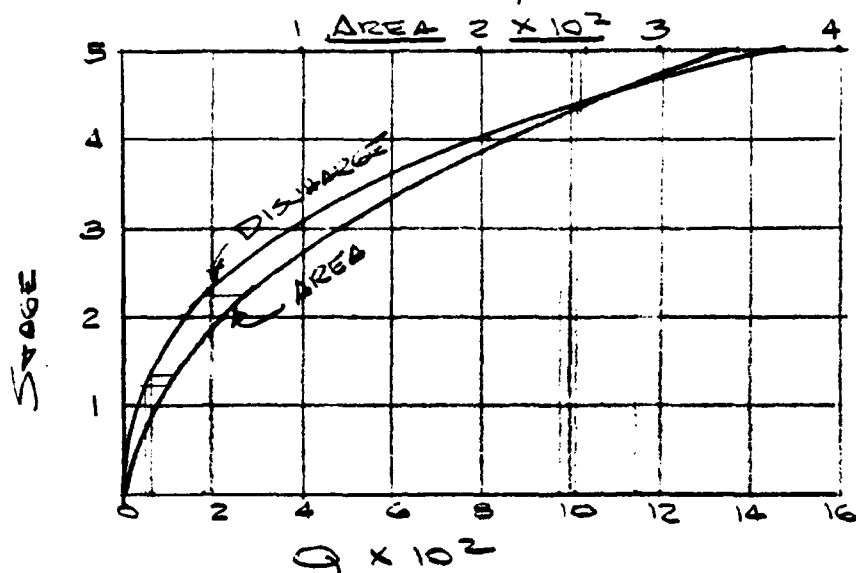
BY RFB DATE 11-24-80 LOUIS BERGER & ASSOCIATES, INC.

SHEET NO. 2 OF 5

CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_

PROJECT W-RE

SUBJECT WILLIAMS LAKE DAM, FAILURE ANALYSIS



FOR  $Q = 1140$ , STAGE = 4.6 FT., AREA = 288  
 "  $Q = 180$ , " = 68  
 $\Delta A = 220$

$$V_1 = \frac{220 \times 1400}{43560} \approx 7 \text{ AF.}$$

$$Q_{P2} (\text{TRIAL}) = 1140 \left(1 - \frac{7}{300}\right) \\ = 1110 \text{ CES}$$

FOR  $Q = 1110$ , STAGE = 4.4 FT., AREA = 280  
 "  $Q = 180$ , " = 68  
 $\Delta A = 212$

$$V_2 = \frac{212 \times 1400}{43560} \approx 7.0$$

$$V_{AVE} \approx 7 \text{ AF}$$

SAY  $Q @ I-495 = 1110 \text{ CES}$



BY RFB DATE 11-24-80 **LOUIS BERGER & ASSOCIATES INC.**

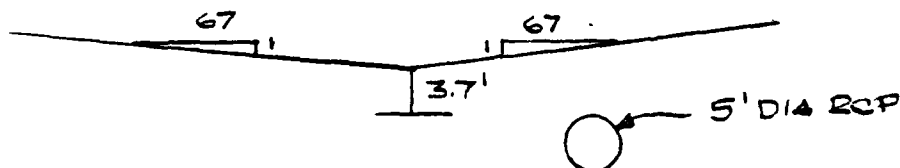
SHEET NO. 3 OF 5

CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_

PROJECT W-198

SUBJECT WILLIAMS LAKE DAM

FAILURE ANALYSIS



ROUTE I-495 CROSSING

HW	HW/D	Q PIPE	H	L	C	Q	Q TOTAL
3.05	0.61	60	0	0	0	0	60
8.7	1.74	260	0	0	0	0	260
10.7	2.14	300	1	268	2.5	670	970

\* FROM F.H.A., HEC No. 5, CHART No. 2

Q = 970 CFS, OVERTOPS I-495 BY 2 FT +

Reach #2, I-495 TO GLEN ST. HOUSING DEVELOPMENT  
L = 1300 FT.

$$S = \frac{390 - 350}{1300} = .0307$$

$$S^{1/2} = 0.175$$

$$n = 0.110$$



$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2} = 2.36 A R^{2/3}$$

STAGE	AREA	P	R <sup>2/3</sup>	Q
2	70	70.12	1.0	165
3	158	105.17	1.31	488
4	280	140.24	1.58	1044
5	438	175.30	1.84	1900

BY RF3 DATE 11-25-80 LOUIS BERGER & ASSOCIATES INC.

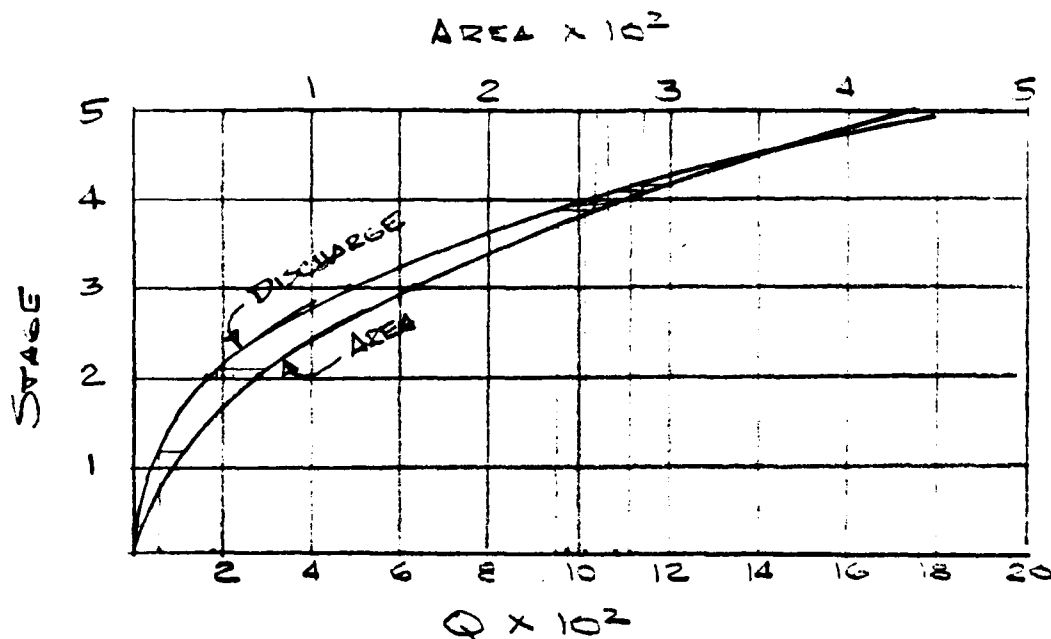
SHEET NO. 4 OF 5

CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_

PROJECT N-198

SUBJECT WILLIAM LAGE DAM

FAILURE ANALYSIS



For  $Q = 1110$ ,  $STAGE = 4.15$ ,  $AREA = 300$

"  $Q = 180$

"  $= 75$

$\Delta A = 225$

$$V_1 = \frac{225 \times 1300}{43,560} = 7 \text{ AF}$$

$$Q_{P2} (\text{TRIAL}) = 1110 \left(1 - \frac{7}{300}\right)$$

$$= 1080 \text{ CFS}$$

For  $Q = 1080$ ,  $STAGE = 4.1$ ,  $AREA = 275$

"  $Q = 180$

"  $= 75$

$\Delta A = 200$

$$V_2 = \frac{200 \times 1300}{43,560} = 6 \text{ AF}$$

$$V_{AVE} \approx 7 \text{ AF}$$

Say  $Q$  @ GLEN ST HOUSING DEVELOPMENT = 1080

BY RF3 DATE 11-25-80 LOUIS BERGER & ASSOCIATES INC.

SHEET NO. 5 OF 5

CHKD. BY \_\_\_\_\_ DATE \_\_\_\_\_

PROJECT \_\_\_\_\_

SUBJECT WILLIAMS LAKE DAM

FAILURE ANALYSIS

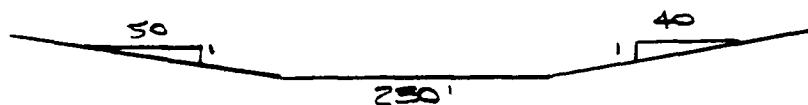
$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

$$S = \frac{5}{1400} = .0036$$

$$Q = 1.19 A R^{2/3}$$

$$S^{1/2} = .060$$

$$n = .075$$

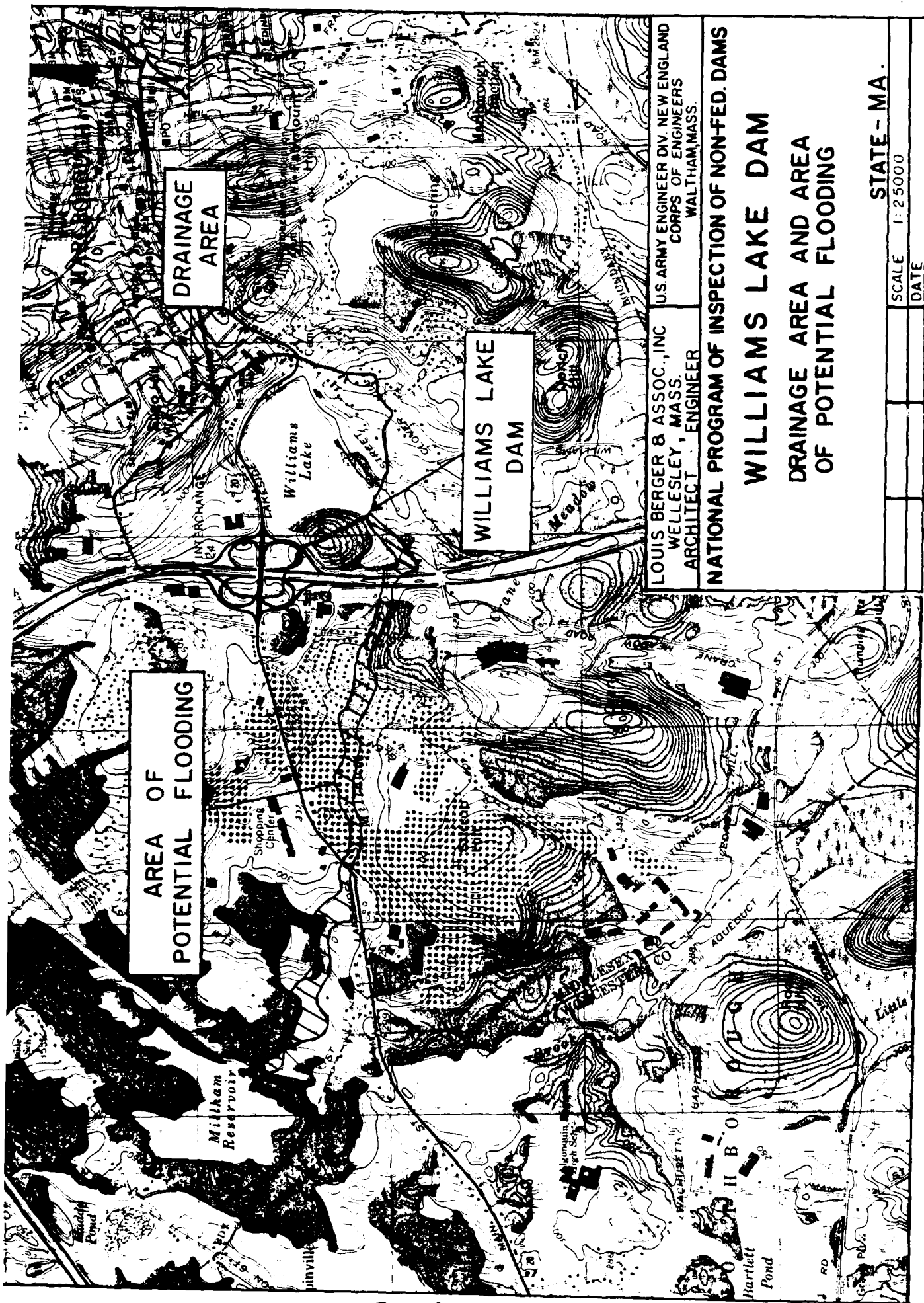


SECTION IN GLEN ST HOUSING DEVELOPMENT

STAGE	AREA	P	$R^{2/3}$	Q
1	295	340	0.91	320
1.5	476	385	1.15	651
2	680	430	1.35	1042

WATER WILL BE ABOUT 2 FT DEEP IN GLEN ST HOUSING DEVELOPMENT, FLOODING ABOUT 20 HOMES IN BASEMENTS AND SEVERAL STREETS.

PREFAILURE STAGE  $\approx$  0.5 FT



AREA OF  
POTENTIAL FLOODING

DRAINAGE  
AREA

WILLIAMS LAKE  
DAM

LOUIS BERGER & ASSOC., INC.  
WELLESLEY, MASS.  
ARCHITECT-ENGINEER

U.S. ARMY ENGINEER DIV. NEW ENGLAND  
CORPS OF ENGINEERS  
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

WILLIAMS LAKE DAM  
DRAINAGE AREA AND AREA  
OF POTENTIAL FLOODING

STATE - MA.

SCALE 1:25000

DATE

Appendix E

Information as Contained in the

National Inventory of Dams

**END**

**FILMED**

**7-85**

**DTIC**